PATENT SPECIFICATION

662,905

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COMPLETE SPECIFICATION

Improvements in Gear Sets

I, ALFRED AUGUSTUS THORNTON, a British Subject, of Napier House, 24/27, High Holborn, London, W.C.1, Chartered Patent Agent, do hereby declare the nature of this invention (a communication from abroad from The Falk Corporation, a corporation organized and existing under the laws of the State of Wisconsin, United States of America, whose post office address is 3001, West Canal St., City of Milwaukee, County of Milwaukee, State of Wisconsin, United States of America) and in what manner the same is to be performed to be particularly described and ascertained in and by the following statement :—

This invention relates to improvements in gear sets.

Gear sets are today available as self-contained articles of commerce. Because of their general use in effecting operation of a driven mechanism at speeds substantially below those of the driving mechanism, they are commonly known as speed reducers, although they are also used at times to effect operation of driven mechanism at speeds above that of the driver.

One object of the present invention is to materially increase the load transmitting capacity of gear sets.

Another object is to substantially reduce the size and weight of a gear set of given load transmitting capacity.

Another object is to provide a gear set having several gear trains compactly arranged and combined in a manner to insure equal division of the total torque load between the several trains.

The invention consists in a gear set including an internal gear and a plurality of gears separately connected in driving relation with such internal gear and all reacting torsionally thereon in the same direction, such plurality of gears being arranged in groups which each engage with one of a plurality of substantially co-axial torsionally interconnected gears.

Referring now to the accompanying drawings :

Figure 1 is a vertical sectional view of a gear set constructed in accordance with the present invention.

Figures 2 and 3 are similar views of other embodiments of the invention.

The gear set shown in Figure 1 comprises a housing having a circular forward portion 10 and a separate circular rear portion 11, separably joined by bolts 12 or otherwise, with a suitable disk or spider 13 secured therebetween.

A low speed shaft 14, projects through the forward housing portion 10. This shaft is journalled in a suitable bearing 15, fixed in the housing portion 10, and in a second bearing 16, fixed in the disk 13, and carries a relatively large internal gear 17 rotatable therewith.

The internal gear 17 is in separate driving connection with each of a plurality of gears arranged in sets. As shown, such gears are six in number and divided into sets. As will be seen, the internal gear 17 meshes with six equally spaced pinions 18 symmetrically disposed therein. The several pinions 18 are carried by separate parallel shafts 19, preferably hollow, which are shown journalled in bearings 20 fixed in the disk 13 and in bearings 21 fixed in the rear housing portion 11.

Each of the shafts 19 carries a gear 22 or 22' keyed or otherwise fixed thereto. Gears 22 constitute a symmetrical group of three equally spaced gears disposed in a common plane and respectively fixed to alternate shafts 19, while gears 22' constitute a similar symmetrical group of three in a common plane offset from the first-mentioned group and respectively fixed to the remaining shafts 19. For reasons which will later appear, both groups of gears 22 and 22' are of single helical type, the helix angle of those of one group being equal to but of opposite hand from those of the other group.

A high speed shaft 23, preferably hollow, carries a single helical pinion 24 that meshes with the gears 22 of one group and a second single helical pinion 24' that meshes with the gears 22' of the other group. The pinions 24 and 24', as it will be appreciated, are substantially co-axial and torsionally connected to each other. The shaft 23 is free to float both radially and axially and is centred and positioned by the tooth reactions between the gears 22 and 22' and pinions 24 and 24'. A circular series of teeth 25 provided on the outer end of the shaft 23 provide a positive driving engagement with a similarly toothed flexible coupling member 26 of a well-known type, through which the desired torque may be transmitted to or from the shaft 23 without interfering with the above described radial and axial freedom of the latter.

It will be noted that the shaft 23 is urged axially in one direction by the tooth reactions between the helical pinion 24 and the helical gears 22 of one group, and that the shaft 23 is also urged axially in an opposite direction by the tooth reaction between the helical pinion 24' and the helical gears 22' of the other group, thereby causing the shaft 23 to automatically assume an axial position such that the total tooth reactions on one pinion 24 are equal to those on the other pinion 24'. By virtue of these conditions the entire torque load transmitted through the shaft 23 is equally divided between the two co-axial pinions 24 and 24' and, consequently, each group of gears 22 and 22' automatically assumes one half of the whole transmitted load.

It will be further noted that the teeth of each of the gears 22 of one group react on the meshing pinion 24 to urge the latter radially, thereby causing the pinion 24 to automatically assume a position such as to equalize the tooth reactions between it and each of the meshing gears 22, and causing each of the three gears 22 to assume an equal one-third part of the torque load transmitted through the meshing pinion 24. Similarly each of the three gears 22' of the other group automatically assumes an equal one-third part of the torque load transmitted through the meshing pinion 24' so that the entire torque load transmitted through the high-speed shaft 23 is equally divided six ways between the six gears 22 and 22'.

Sinct the entire torque load is thus equally divided between the six gears 22 and 22', each of the six pinions 18 is subjected to only one-sixth of the entire transmitted load.

As a consequence of this arrangement, each of the pinions and gears shown may be safely designed to carry only one-sixth of the total transmitted load; thereby making it possible to materially reduce the size and weight of the individual elements and to obtain a compactness of design not heretofore possible. Moreover, with the gears and pinions arranged and co-acting in the manner above described, a gear set of a given size and weight is capable of transmitting a much greater total torque load than was heretofore possible with gear sets of comparable size or weight.

The gear set shown in Figure 2 embodies many of the advantageous features of that shown in Figure 1, but involves structure that makes possible the use of spur or double helical gearing instead of the single helical gearing shown in Figure 1.

The housing shown in Figure 2, like that of Figure 1, includes a forward section 30 detachably joined to a rear section 31, with a suitable disk or spider 33 secured therebetween. A low-speed shaft 34, journalled in a bearing 35 in the forward section 30 of the housing and in a bearing 36 in the supporting disk 33, supports a large internal gear 37 rotatable therewith.

Six equally-spaced pinions 38 mesh with the gear 37. Each of the pinions 38 is carried by the forward end of a shaft 39. Shafts 39 are journalled in bearings 40, fixed in the disk 33, and in bearings 41 fixed in the rear housing section 31. A group of three herring-bone gears 42, respectively keyed or otherwise fixed to alternate shafts 39, mesh with a high-speed pinion 44; and a second group of three similar gears 42', respectively keyed or otherwise fixed to the remaining three shafts 39, mesh with a high-speed pinion 44'. As in the case of the pinions 24 and 24' of Figure 1, the pinions 44 and 44' are substantially co-axial and torsionally connected to each other.

In this instance the pinions 44 and 44' are shown carried by separate hollow shafts or sleeves 43 and 43' each of which is free to float both axially and radially. A high-speed shaft 45, extending loosely through the sleeves 43 and 43', is supported largely by a bearing 46 fixed in the rear housing portion 31 and is piloted at its forward end 47 within the adjacent end of the low-speed shaft 34.

The shaft 45 is shown flexibly connected in driving relation with both sleeves 43 and 43' through a plurality of pins 48 designed and arranged to insure that each pinion 44 and 44' will assume an equal one-half part of the total torque load transmitted through the shaft 45. In this instance each pin 48 is rockably seated midway of its ends within a collar 49 carried by shaft 45 and with the opposite ends of each rockably seated within flanges 49' on the adjacent ends of sleeves 43 and 43', respectively. One-half of the transmitted load is thus assumed by each group of gears 42 and 42'. Since each pinion 44 and 44' is free to float radially, that portion of the load transmitted through each is equally divided between the three gears 42 and 42' engaged therewith, so that each of the gears 42 and 42' assumes an equal one-

sixth part of the total load, this also being true of the several pinions 38 respectively connected therewith.

The gear set of Figure 2 thus possesses many of the advantages of that of Figure 1, and since the Figure 2 device does not rely upon axial displacement of gears to insure equal division of the load, gears other than single helical gears may be employed therein.

The gear set shown in Figure 3 involves twelve gear trains so constructed and arranged as to insure that each train will automatically assume and transmit an equal one-twelfth part of the entire torque load. It includes a low-speed shaft 54, suitably journalled in a forward housing portion 50, and supporting a large internal gear 57 rotatable therewith. In this instance the gear 57 is carried by a drum 55 secured to a disk 56 provided on the inner end of the shaft 54.

Twelve pinions 58 carried by separate hollow shafts 59 mesh with the gear 57. Each of the shafts 59 is journalled adjacent its rear end in a supporting disk 53 releasably secured between the forward and rear housing portions 50 and 51. The forward ends of the respective shafts 59 are journalled in a heavy ring 60 formed on a cylindrical structure 61 bolted or otherwise securely anchored to the supporting disk 53.

Six single helical gears 62 and 62' are fixed, respectively, to the forward ends of alternate shafts 59, the gears 62 constituting a group of three equally spaced gears which mesh with a single helical pinion 63, and the gears 62' constituting a similar group of three meshing with a separate pinion 63'. Fixed to the rear end of each of the other shafts 59 is a single helical gear 64 or 64'. Gears 64 constitute a group of three equally spaced gears meshing with a single helical pinion 65, and gears 64' constitute a similar group of three equally spaced gears meshing with a separate single helical pinion 65'. In this form of the invention, the four pinions 63, 63', 65 and 65' are substantially co-axial and torsionally connected to each other.

The pinions 63 and 63' are shown formed on the forward end of a hollow shaft 66 which is free to float both radially and axially, and the other pinions 65 and 65' are similarly carried by the rear end of a separate hollow shaft 67 which is also free to float in a similar manner.

A high-speed shaft 68, extending loosely through the hollow shafts 66 and 67, is journalled at its rear end 69 in the rear housing portion 51 and at its forward end 70 in a bearing 71 fixed in the rear end of the low-speed shaft 54. A plurality of pins 72, rockably seated intermediate their ends in a collar 73 on shaft 68, and rockably engaged at their opposite ends in adjacent end flanges 74 on the hollow pinion shafts 66 and 67, respectively, function in a manner similar to the pins 48 of Figure 2 to provide a flexible driving connection between the shaft 68 and hollow shafts 66 and 67 and to insure that each of the latter assumes an equal one-half part of the torque load transmitted through the shaft 68.

Since the single helical gears 62 of one group are of opposite hand with respect to the gears 62' of the adjacent group, and since the hollow pinion shaft 66 is free to float axially, the single helical pinions 63 and 63' react in the manner hereinabove explained to equally divide between these two groups of gears that portion of the torque load assumed by the pinion shaft 66. Also, since both pinions 63 and 63' are free to float radially, that portion of the load assumed by each group of gears is equally divided between the three gears of each group. Therefore, each of the six gears 62 and 62', as well as the pinions 58 with which they are separately connected, sustains an equal one-sixth part of that portion of the load transmitted through the pinion shaft 66. Likewise, each of the six gears 64 and 64', as well as the pinions 58 with which they are separately connected, sustains an equal one-sixth part of the torque load transmitted through the hollow pinion shaft 67.

Consequently each of the pinions and gears included in the gear set shown in Figure 3 may be safely designed to transmit only one-twelfth of the total torque load transmitted by the set.

In the gear set shown in Figure 3 provision is made for accurately relating the several helical gears 62, 62', 64 and 64', so as to reduce to a minimum the radial or axial displacement of the pinions 63, 63', 65 and 65' normally required to insure the above described equal divisions of the total torque load. For this purpose each of the several helical gears is mounted for rotative adjustment relative to its supporting shaft 59, suitable means being provided for securely locking the same in any position of adjustment.

In this instance one end of each shaft 59 is reduced, as at 75, to form a shoulder having a tapered seat 76 fashioned to match an inwardly tapered surface 77 formed in the hub 78 of the supported gear. A clamp ring 79, seated on the reduced portion 75 and in splined engagement therewith, is provided with an oppositely tapered seat 80 adapted to match a second inwardly tapered surface 81 formed in the gear hub. The ring 79 is fixed to a head 82 having a stem 83 extending therefrom lengthwise through the hollow shaft 59. Any suitable means, such as a nut 84 on the stem and co-acting with the end of the shaft, may be employed to draw the clamp ring 79 into tight wedging engagement within the gearhub 78 with sufficient pressure

to substantially lock the hub in engagement with the ring 79 and shoulder 76.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed I declare that what I claim is :—

1. A gear set including an internal gear and a plurality of gears separately connected in driving relation with such internal gear and all reacting torsionally thereon in the same direction, such plurality of gears being arranged in groups which each engage with one of a plurality of substantially co-axial torsionally interconnected gears.

2. A gear set in accordance with Claim 1 in which the co-axial gears react on the gears of the groups to automatically distribute the total torque load between the latter.

3. A gear set in accordance with Claim 1 or 2 in which there are two groups of gears and two co-axial gears, each of said co-axial gears meshing with the gears of one of said groups.

4. A gear set in accordance with any preceding claim in which there are three gears in each group of gears.

5. A gear set in accordance with any preceding claim in which the separate gears of each of the groups of gears are individually connected to the internal gear through separate pinions engaged with such internal gear.

6. A gear set in accordance with any preceding claim in which the co-axial gears are free to float radially.

7. A gear set in accordance with any preceding claim in which the co-axial gears are free to float axially.

8. A gear set in accordance with any preceding claim in which the co-axial gears include two single helical gears of opposite hand.

9. A gear set substantially as hereinabove described and illustrated by any one of the accompanying figures.

Dated this 19th day of August, 1949.

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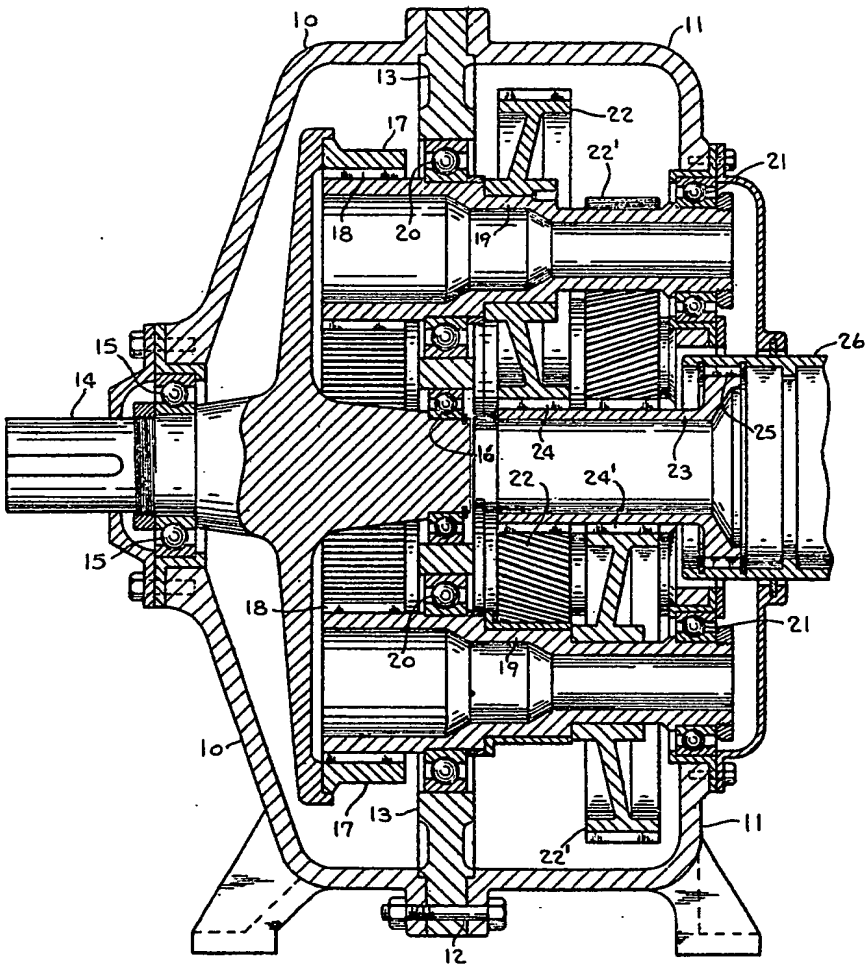


FIG. 1

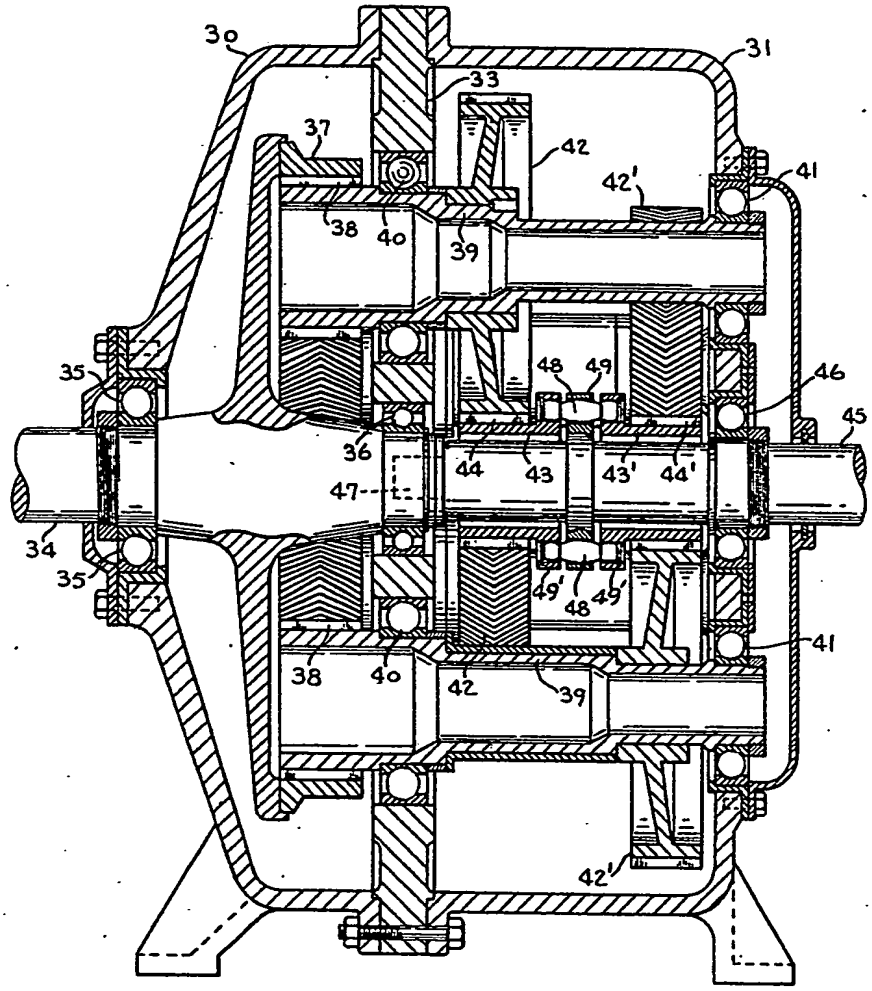
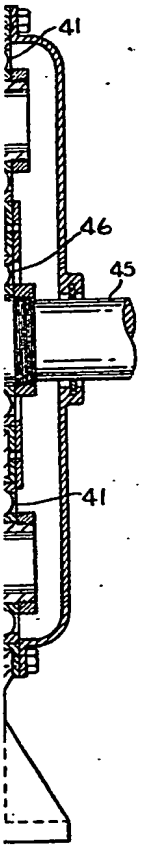


FIG. 2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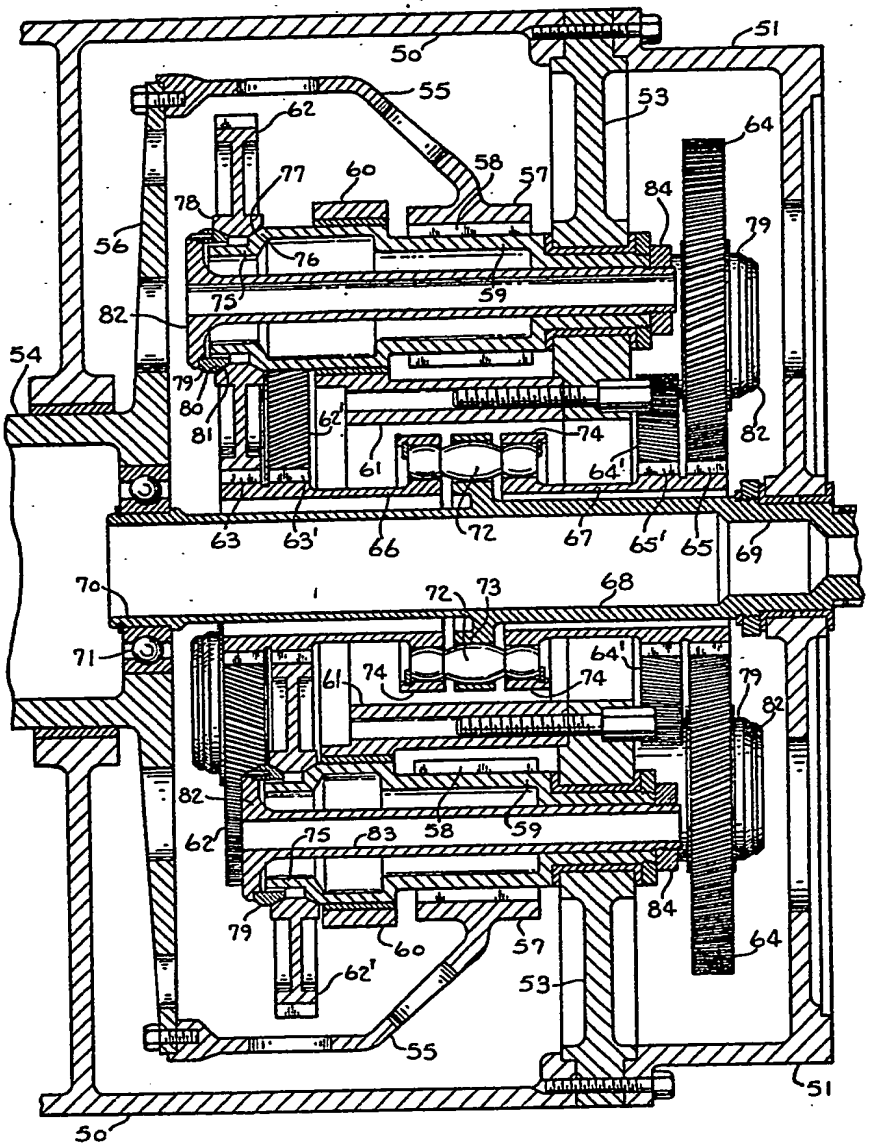
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FIG. 3

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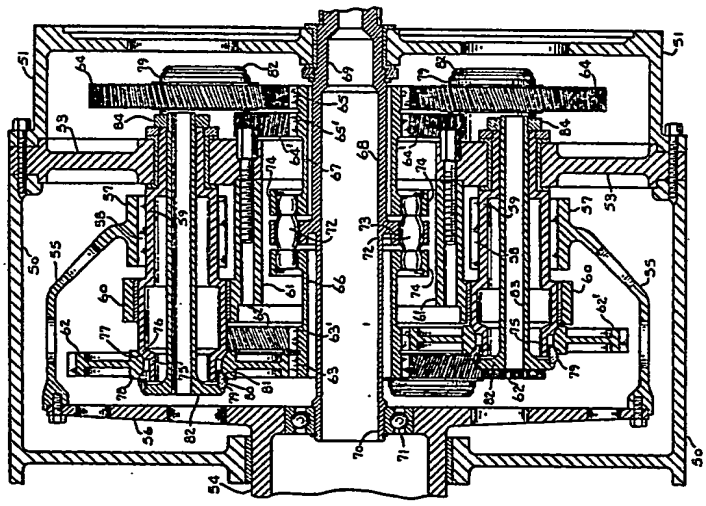

FIG. 3

SHEET 2

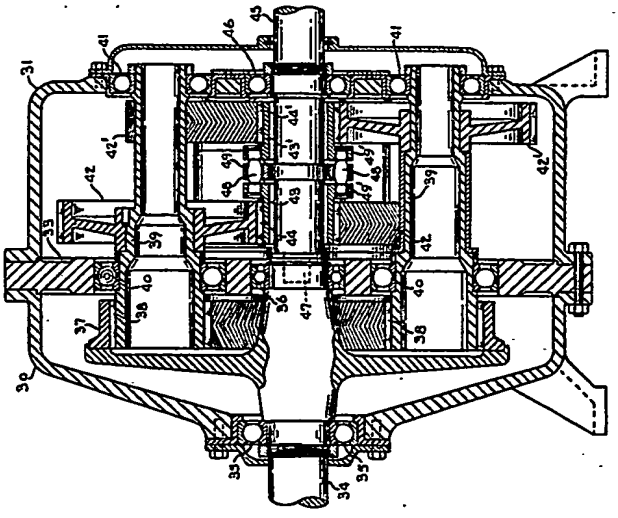

FIG. 2

662,905 COMPLETE SPECIFICATION